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U S NAVAL PROVING GROUND

DAHLGREN VIRGINIA

REPORT NO 1149

TESTING OF WARHEADS FOR
AIR TARGET GUIDED MISSILES65th Partial Report-----
FRAGMENTATION TEST OF WARHEAD
NO 1145 FOR ORIOLE MISSILEFINAL ReportTask
Assignment S-6 Ref 607 53Cop. No 11Classification CONFIDENTIAL
SECURITY INFORMATION

Fragmentation Test of Warhead No. 145 for Oriole Missile

PART A

SYNOPSIS

1. The testing of warheads 145-A, 145-B, 145-C, and 145-D was conducted to determine the effect of geometry of explosive loading on the fragment velocity and space distribution pattern of Oriole warheads having small length to diameter ratios. The warheads were cylinders 10" in outside diameter and 4" in length with various end plate designs.
2. a. Warheads 145-A, 145-B, 145-C and 145-D produced fragment velocities which increased as the weight of explosive was increased.
 - b. Warheads 145-A with flat end plates, warheads 145-B with conical end plates oriented to reduce the charge, and warheads 145-C with conical end plates oriented to increase the charge all had similar space distribution patterns.
 - c. Warhead 145-D, which had higher cones and more explosive than warhead 145-C, used a dual initiation. It showed a great increase in the number of fragments over warheads 145-A, 145-B, and 145-C and a wider beam spread. It would appear that the wider spread is a result of the dual initiation, but no definite conclusion can be reached since no warhead of similar geometry was tested with single initiation.

Fragmentation Test of Warhead No. 145 for Oriole Missile

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Fragmentation Test of Warhead No. 145 for Oriole Missile

PART BINTRODUCTION

1. AUTHORITY:

This test was authorized by reference (a) and conducted under Task Assignment NPG-Re3f-607-1-53, reference (b).

2. REFERENCES:

- a. NOL Conf Work Request WC/40/53 of 10 March 1953
- b. BUORD Conf ltr NP9-Re3f-RKJ:gg Ser 42699 of 29 July 1952

3. BACKGROUND:

a. Reference (b) authorized the Naval Proving Ground to work directly with the Naval Ordnance Laboratory in the development and testing of warheads for guided missiles.

b. Reference (a) requested that 12 warheads No. 145, 3 of each modification 145-A, 145-B, 145-C and 145-D made of cylindrical cases, 10" in diameter and 4" long, and having four (4) styles of end plates be loaded with composition C-3 and tested for fragment velocity and space distribution.

4. OBJECT OF TEST:

The testing of warheads 145-A, 145-B, 145-C, and 145-D was intended to determine the effect of geometry of explosive loading on the fragment velocity and space distribution pattern of Oriole warheads having small length to diameter ratios.

5. PERIOD OF TEST:

a. Date of Project Letter	10 March 1953
b. Date Necessary Material Received	17 March 1953
c. Date Commenced Test	15 April 1953
d. Date Test Completed	24 April 1953

6. REPRESENTATIVES PRESENT:

This test was witnessed in part by Messrs. L. E. Hightower, D. J. Stremator and P. Popernack representing the Naval Ordnance Laboratory.

Fragmentation Test of Warhead No. 145 for Oriole Missile

PART CDETAILS OF TEST

7. DESCRIPTION OF ITEMS UNDER TEST:

a. The twelve (12) warheads No. 145 were cylinders of steel 10"0 in outside diameter, 4"0 long and 3/8" wall thickness. Three each of these were designated for the 4 types of end plates, A, B, C, and D.

b. Warheads 145-A, Figure 1, used flat end plates 1/16" thick. One end plate contained a hole 2" in diameter where a 1" tetryl booster was placed. Warheads 145-B and 145-C, Figures 2 and 3, had cone shaped end plates 1/16" thick, 1-1/2" high truncated by a 2" hole for the boosters. In warhead 145-B the cones were turned inward and in 145-C the cones were oriented outward. Warhead 145-D, Figure 4, was similar to warhead 145-C with the single exception that the cone-shaped end plates were 3" high.

c. Warheads 145-A, 145-B and 145-C were each initiated at the top (0°) with an engineers' special blasting cap and 1" x 1" tetryl booster, while warheads 145-D were each dually initiated at the top and bottom (0° and 180°) by an engineers' special blasting cap and two primacord leads to two 1" x 1" tetryl boosters. The detonation train for warheads 145-D is shown in Figure 5.

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d. The warhead and filler weights are as follows:

Oriole Warheads NOL 145-A-B-C-D

30' Velocity Arena

Warhead No.	Empty wt. lbs.	Comp. C-3 wt. lbs.	Total wt. lbs.	Cone* heights
145-A-1	15.74	15.54	31.28	0"
145-A-2	15.61	15.36	30.97	0"
145-A-3	15.38	15.49	31.07	0"
145-B-1	15.86	11.06	26.92	-1-1/2"
145-B-2	15.85	11.03	26.88	-1-1/2"
145-B-3	15.76	11.21	26.97	-1-1/2"
145-C-1	15.83	19.99	35.82	+1-1/2"
145-C-2	15.69	19.86	35.55	+1-1/2"
145-C-3	15.85	19.88	35.73	+1-1/2"
145-D-1	16.23	24.97	41.20	+3"
145-D-2	16.29	24.99	41.28	+3"
145-D-3	16.17	25.06	41.23	+3"

* See Figures 1, 2, 3, and 4.

8. PROCEDURE:

Each warhead was placed with its axis vertical at the center of a 30' radius arena on a 7-1/2' high platform. Fragment velocities were obtained by recording hits with a 16mm Fastax camera. The 30 ft. radius velocity arena consisted of steel plates 1" thick in longitudinal zones 350° to 50°, called "L", and 123° to 183°, called "R" in Table XII. Space distribution was determined by dividing these plates into polar zones of 5° each from 75° to 100°. In these zones all hits were recorded if they were estimated to be able to penetrate 1/8" mild steel plate. The recorded hits represent 1/3 of the number expected for the total polar zones.

Fragmentation Test of Warhead No. 145 for Oriole Missile

9. RESULTS AND DISCUSSION:

a. The velocity results, detailed in Tables I through XI, are summarized as follows:

<u>Warheads</u>	<u>Cone heights</u>	<u>Average Charge (lbs.)</u>	<u>Average Velocity</u>
145-A	0"	15.5	4460 ft./sec.
145-B	-1-1/2"	11.1	4220 ft./sec.
145-C	+1-1/2"	19.9	4770 ft./sec.
145-D	+3"	25.0	5590 ft./sec.

b. The space distribution data detailed in Table XII are summarized in the following table.

<u>Polar Zone</u>	<u>3 round Average of No. of hits on Arena</u>			
	<u>145-A*</u>	<u>145-B</u>	<u>145-C</u>	<u>145-D</u>
75°-80°	7	5	4	14
80°-85°	8	5	15	43
85°-90°	36	48	18	70
90°-95°	75	74	68	71
95°-100°	8	5	7	30
Total	134	137	112	228
<u>% in Zone</u>				
85°-95°	82.5	88.6	78.7	61.7

* 2 round average, No. 145-A-1 did not detonate.

It appears that by dually initiating warhead No. 145-D, a wider beam of fragments resulted.

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PART D

CONCLUSIONS

10. a. Warheads 145-A, 145-B, 145-C, and 145-D produced velocities which increased as the weight of the explosive was increased.

b. Warheads 145-A, 145-B, and 145-C had relatively similar space distribution patterns.

c. Warhead 145-D, which had a dual initiation showed a great increase in the number of fragments than warheads 145-A, 145-B and 145-C and had a wider beam spread. It would appear that the wider spread is a result of the dual initiation, but no definite conclusion can be reached since no warhead of similar geometry was tested with single initiation.

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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Sixty-fifth Partial Report

on

Testing of Warheads for
Air Target Guided Missiles

Final Report

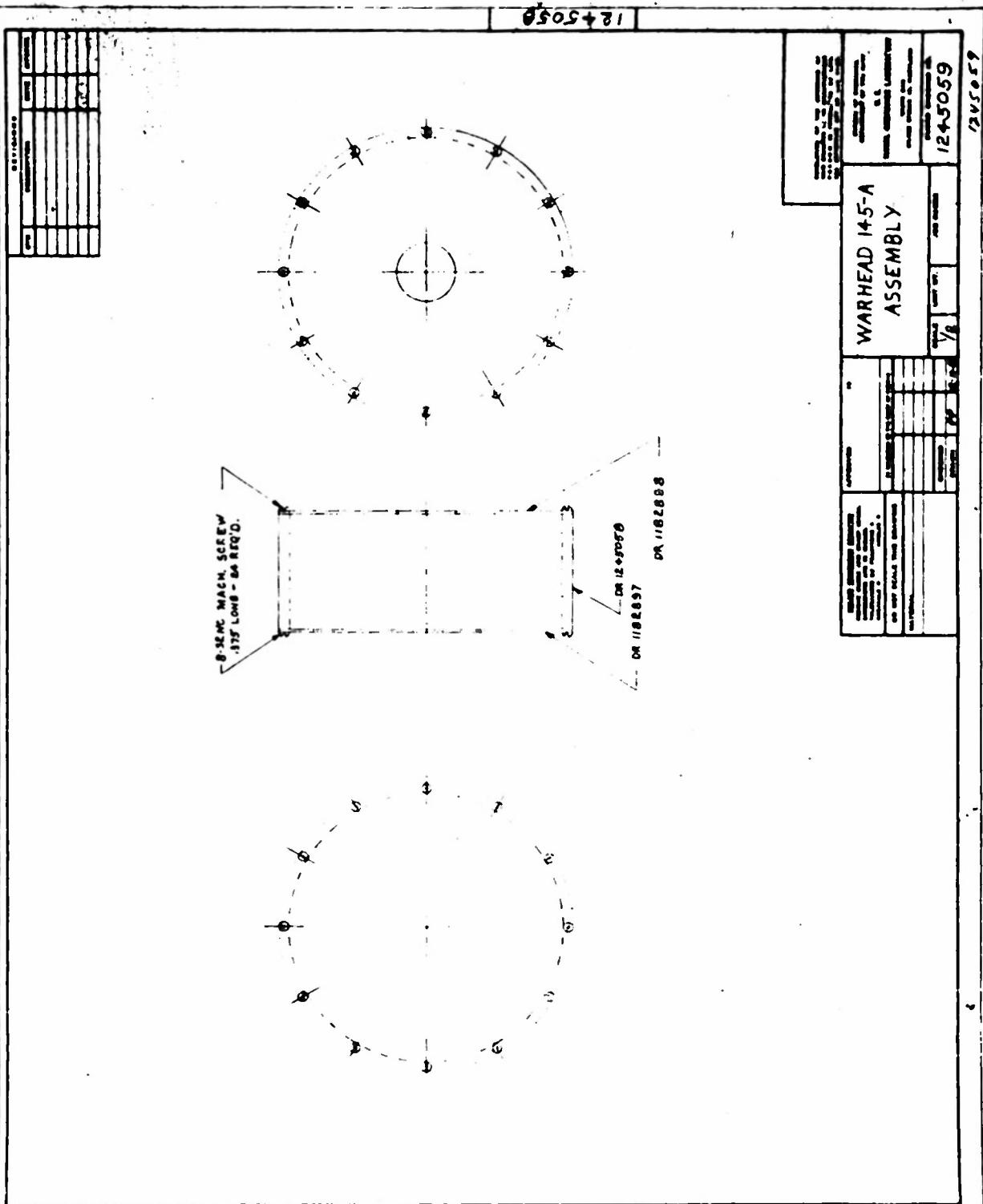
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Fragmentation Test of Warhead
No. 145 for Oriole Missile

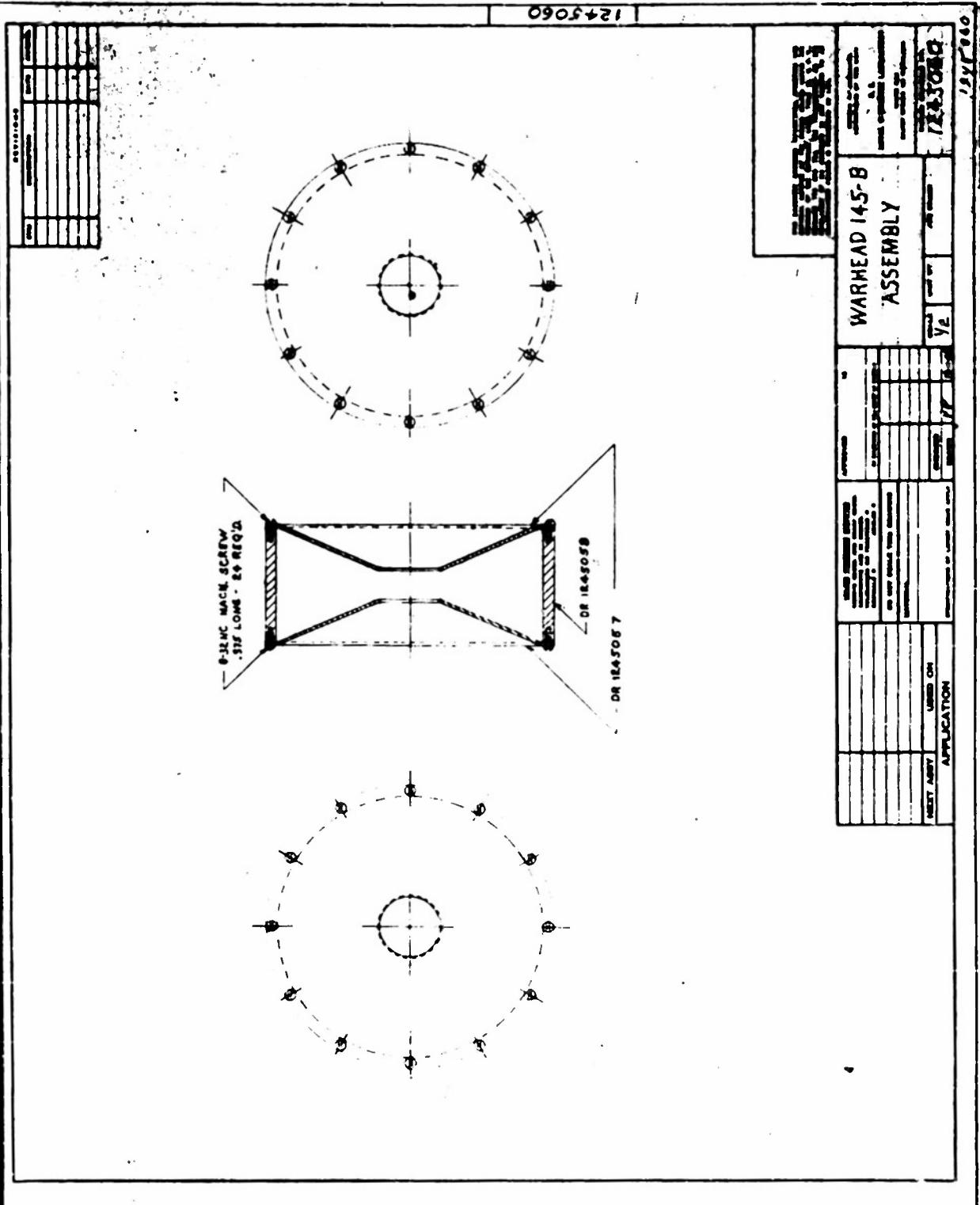
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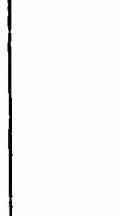
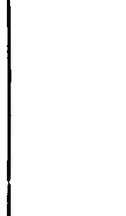
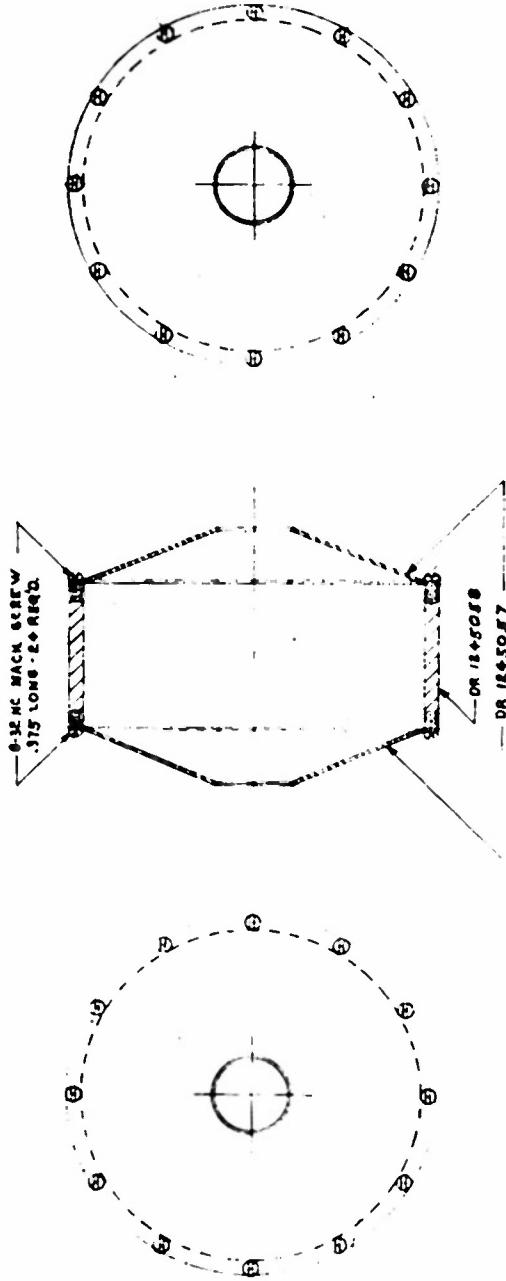
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WARHEAD 145-C
ASSEMBLY

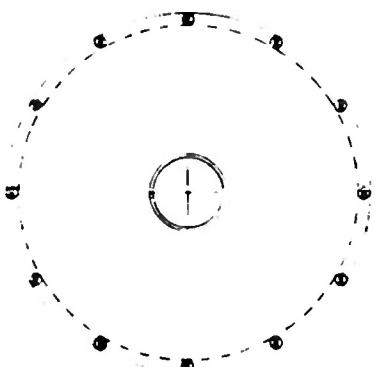
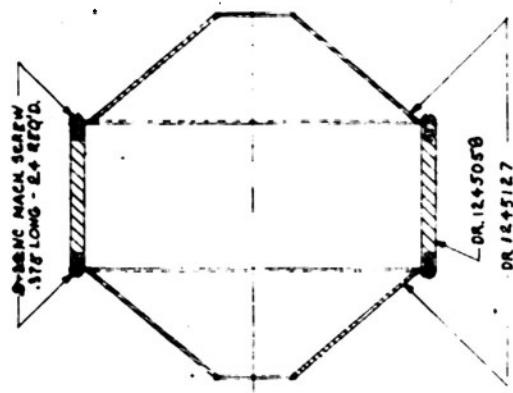
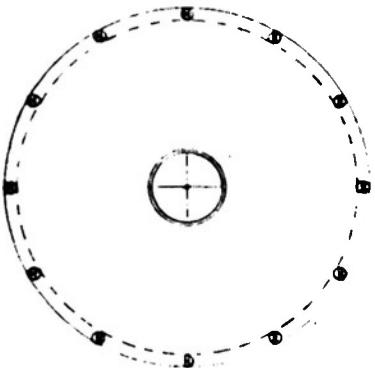
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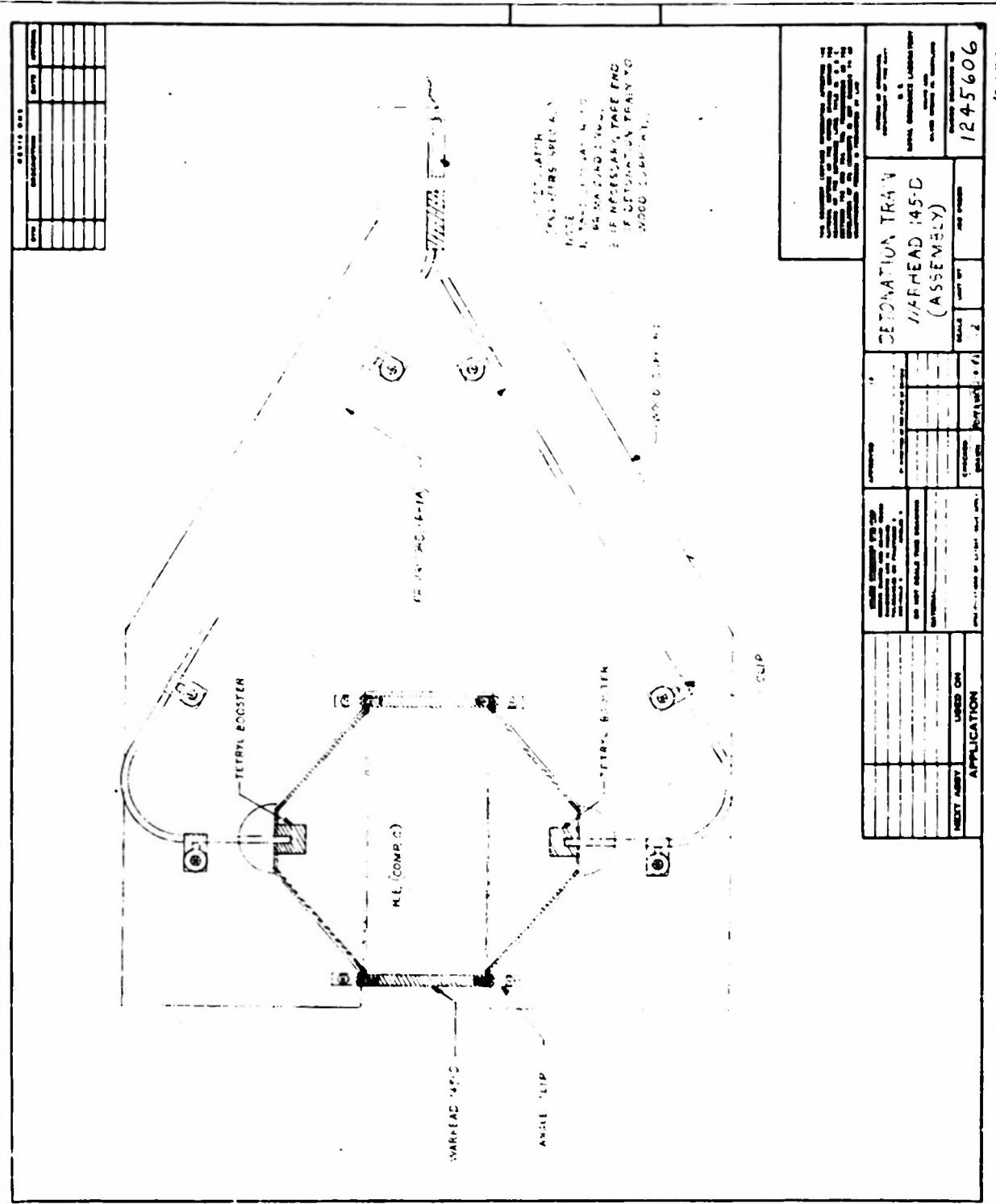
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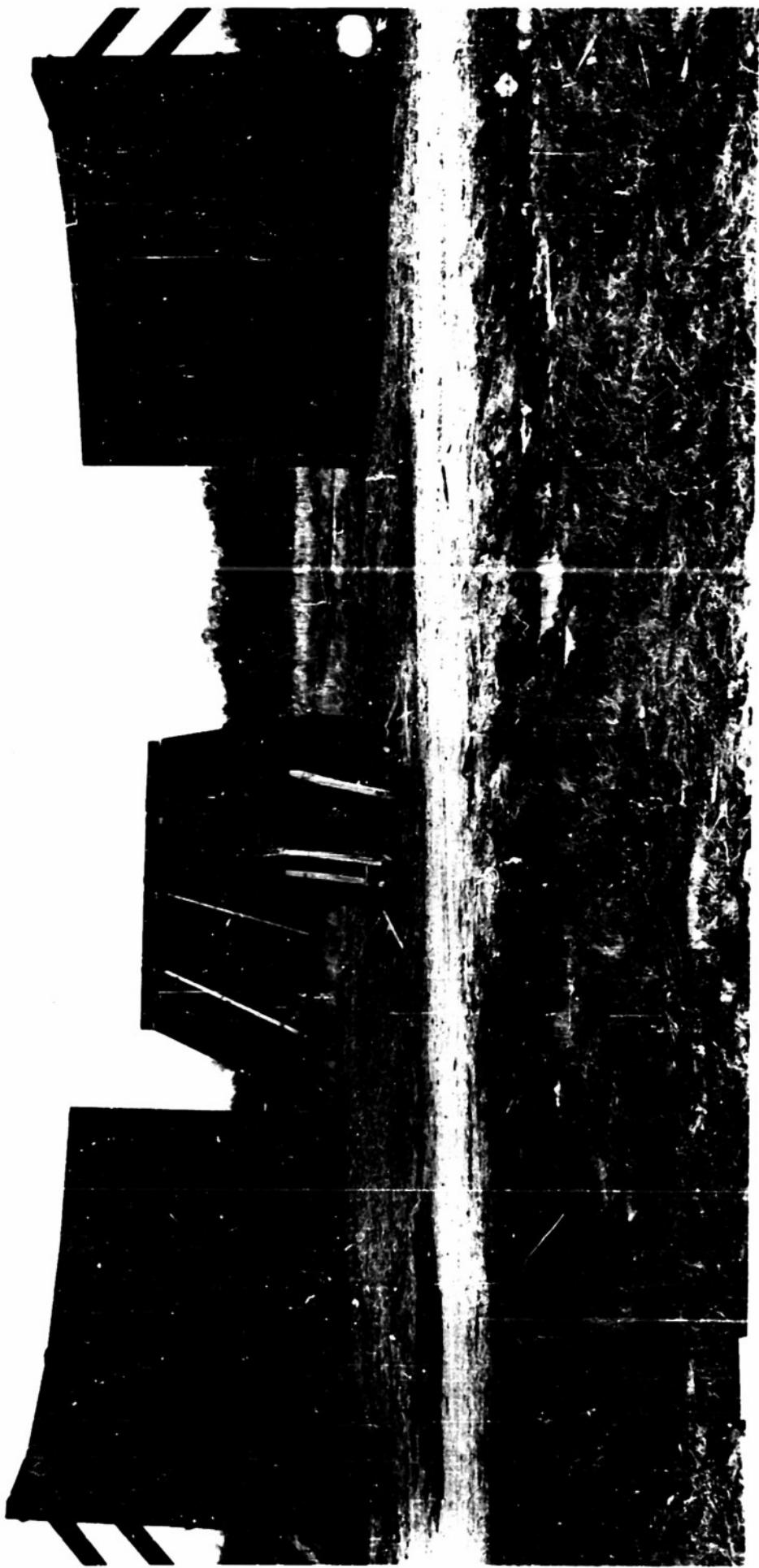
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NP9-63359 30 ft. Arena with Warhead 1452D in place.
15 April 1953
Figure 6



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Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE I

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5850 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 2, Oriole Warhead No. 145-A-2 Filler Weight 15.36 lbs.
Total Weight 30.97 lbs. Date: 15 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
35	8	5010
36	7	4880
37	7	4740
38	4	4620
39	1	4500
41	2	4280
42	6	4180
43	5	4080
44	4	3990
45	5	3900
46	2	3820
47	2	3730
Median		4520
Average		4430

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TABLE II

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 4650 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 3, Oriole Warhead No. 145-A-3 Filler Weight 15.49 lbs.
Total Weight 31.07 lbs. Date: 15 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
27	2	5170
28	19	4980
29	4	4810
30	6	4650
31	3	4500
32	1	4360
33	5	4230
34	7	4100
35	5	3990
36	3	3880
37	1	3770
38	1	3670
39	2	3580
40	1	3490
Median		4630
Average		4490

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TABLE III

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5850 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 10, Oriole Warhead No. 145-B-1 Filler Weight 11.06 lbs.
Total Weight 26.92 lbs. Date: 17 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
38	4	4620
39	6	4500
40	4	4390
41	5	4280
42	8	4180
43	5	4080
44	3	3990
45	1	3900
47	1	3730
50	1	3510
51	2	3440
Median		4290
Average		4210

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TABLE IV

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5800 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 11, Oriole Warhead No. 145-B-2 Filler Weight 11.03 lbs.
Total Weight 26.88 lbs. Date: 17 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
38	4	4580
39	10	4460
40	11	4350
41	9	4240
42	5	4140
43	4	4050
47	1	3700
49	1	3550
52	1	3350
Median		4360
Average		4270

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TABLE V

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5700 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 12, Oriole Warhead No. 145-B-3 Filler Weight 11.21 lbs.
Total Weight 26.97 lbs. Date: 17 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
37	2	4620
38	9	4500
39	5	4380
40	5	4280
41	4	4170
42	5	4070
43	2	3980
44	2	3890
45	1	3800
46	1	3720
48	1	3560
50	1	3420
51	2	3350
Median		4300
Average		4180

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TABLE VI

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 6100 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 4, Oriole Warhead No. 145-C-1 Filler Weight 19.99 lbs.
Total Weight 35.82 lbs. Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
35	7	5230
36	6	5080
37	7	4950
38	5	4820
39	9	4690
40	5	4580
41	7	4460
42	3	4360
43	2	4260
44	1	4160
Median		4830
Average		4770

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TABLE VII

FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5800 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 5, Oriole Warhead No. 145-C-2 Filler Weight 19.86 lbs.
Total Weight 34.45 lbs. Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
33	1	5270
34	13	5120
35	14	4970
36	5	4830
37	2	4700
38	8	4580
39	7	4460
40	3	4350
41	4	4240
42	2	4140
Median		4870
Average		4760

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TABLE VIII
FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5800 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 6, Oriole Warhead No. 145-C-3 Filler Weight 19.88 lbs.
Total Weight 35.73 lbs. Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
33	3	5270
34	10	5120
35	7	4970
36	5	4830
37	6	4700
38	7	4580
39	3	4460
40	2	4350
41	3	4240
42	1	4140
43	1	4050
Median		4870
Average		4780

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TABLE IXFRAGMENT VELOCITY DATA

30' Radius Velocity Arena 6200 Frames per sec.
 16mm Fastax Camera Comp. C-3
 Rd. 7, Oriole Warhead No. 145-D-1 Filler Weight 24.97 lbs.
 Total Weight 41.20 lbs. Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
30	6	6200
31	25	6000
32	21	5810
33	9	5640
34	6	5470
35	4	5310
36	3	5170
37	2	5030
38	1	4890
39	3	4770
40	7	4650
41	2	4540
42	1	4430
Median		5810
Average		5610

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TABLE X
FRAGMENT VELOCITY DATA

30' Radius Velocity Arena 5850 Frames per sec.
16mm Fastax Camera Comp. C-3
Rd. 8, Oriole Warhead No. 145-D-2 Filler Weight 24.99 lbs.
Total Weight 41.28 lbs. Date: 16 April 1953

<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
29	5	6050
30	20	5850
31	21	5660
32	9	5480
33	2	5320
34	1	5160
35	1	5010
36	3	4880
37	2	4740
38	2	4620
39	3	4500
Median		5700
Average		5550

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TABLE XI
FRAGMENT VELOCITY DATA

30' Radius Velocity Arena	5900 Frames per sec.	
16mm Fastax Camera	Comp. C-3	
Rd. 9, Oriole Warhead No. 145-D-3	Filler Weight 25.06 lbs.	
Total Weight 41.23 lbs.	Date: 17 April 1953	
<u>Frame in Which Hit Occurred</u>	<u>No. Fragments</u>	<u>Velocity (f/s)</u>
29	3	6100
30	26	5900
31	23	5710
32	8	5530
33	5	5360
34	2	5210
35	3	5060
36	2	4920
37	2	4780
38	1	4660
39	1	4540
40	2	4430
Median		5760
Average		5600

Fragmentation Test of Warhead No. 145 for Oriole Missile

TABLE XII

SPACE DISTRIBUTION DATA

30' Radius Velocity Arena
1" Panels 15' high

Hit numbers recorded are estimated as
being able to penetrate 1/8" mild steel.

Polar Zone	145-A-1		145-A-2		145-A-3		Ave. No. hits on panels	No. Hits per total 5° zone
	L	R	L	R	L	R		
75°-80°	*Did		1	3	5	4	6.5	19.5
80°-85°			1	5	5	6	8.5	25.5
85°-90°	not		14	21	15	22	36	108
90°-95°			39	37	39	34	74.5	223.5
95°-100°	detonate		8	5	2	4	8.5	25.5
	145-B-1		145-B-2		145-B-3			
	L	R	L	R	L	R		
75°-80°	1	0	3	2	6	4	5.3	16
80°-85°	1	3	4	2	3	3	5.3	16
85°-90°	24	24	22	29	24	20	51	153
90°-95°	58	53	39	29	41	42	74	222
95°-100°	2	0	2	0	6	5	5	16
	145-C-1		145-C-2		145-C-3			
	L	R	L	R	L	R		
75°-80°	2	0	1	4	2	4	4.3	13
80°-85°	6	4	15	12	8	1	15.3	46
85°-90°	15	9	4	14	8	4	18	54
90°-95°	31	25	37	25	41	35	64.7	194
95°-100°	2	6	8	4	2	4	7	21
	145-D-1		145-D-2		145-D-3			
	L	R	L	R	L	R		
75°-80°	8	12	4	4	6	9	14.3	43
80°-85°	19	29	13	34	19	15	43	129
85°-90°	36	41	25	34	48	35	70	210
90°-95°	39	38	36	18	37	44	70.7	212
95°-100°	15	4	16	20	15	21	30.3	91

* The tetryl in warhead 145-A-1 ignited the Composition C-3 filler causing to burn.